Galactic interstellar gas to planets: revealing a multi-scale picture of planet formation

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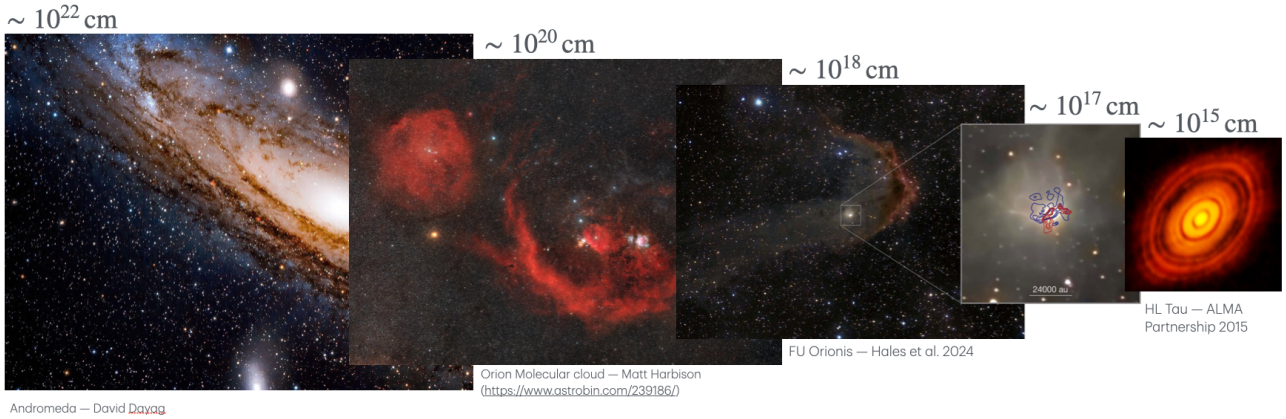

Figure 1: Illustration of some of the spatial scales involved in understanding the planet formation, from galactic (left) down to the planetary system (right) scale.

Over the past three decades, observational astronomy has uncovered both an enormous diversity of planetary systems and the 'protoplanetary discs' of dust and gas from which they form. However, from a theoretical perspective the physical processes that drive planet formation, setting the properties of observed (exo)planets, remain unclear. Establishing the formation pathways for different types of planetary system is one of the foremost challenges of modern astrophysics, and goes to the heart of putting the Solar System into its galactic context (Figure 1).

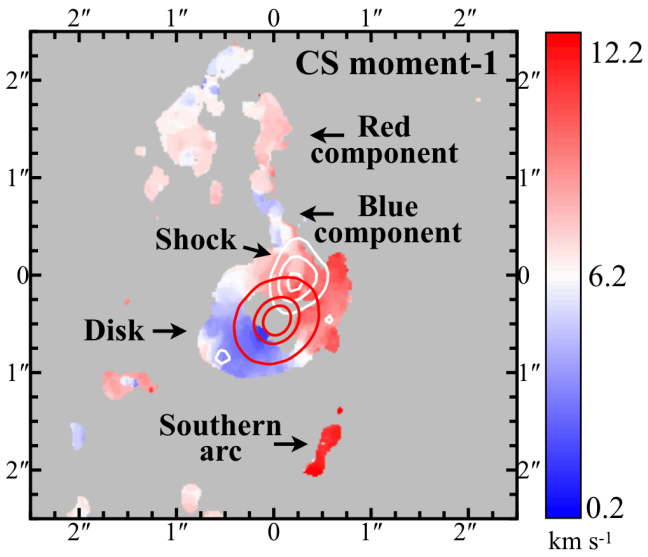

Figure 2: Line-of-sight motion of molecular gas surrounding the protoplanetary disc of the star DG Tau, uncovered with recent ALMA observations (Hanawa et al. 2024).

An exciting development of recent years has been the discovery that protoplanetary discs are not isolated systems, but in fact are often connected to the interstellar medium via streamers of material that continue to feed fresh material onto the disc (Figure 2). This revelation carries with it wide-reaching implications, with potential to solve numerous puzzles that have dogged planet formation theory. However, there are also several big unanswered questions that include:

— How much mass is added to disc from the interstellar medium over its lifetime?
— What are the consequences for disc evolution?
— How do thermal winds driven by the star change this picture?

The novel, multi-faceted nature of this area mean that interested candidates can work on a variety of projects depending on strengths and interests. Some examples include: applying machine learning methods to interpret observations, hydrodynamic simulations, and analytic theoretical analysis of how material falls onto the disc.

Note: This project description can be used for the "Research Proposal" part of your application.